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Large Area Damage Testing of Optics

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Abstract

The Laser Damage Group at Lawrence Livermore National Laboratory (LLNL) has developed systems for damage testing meter-sized optical components for the future National Ignition Facility (NIF), an inertial confinement fusion project. The systems can be used to determine damage thresholds over large areas, or to conduct survivability testing at NIF fluences. This type of testing will help to assure the damage performance of large optical components manufactured for the NIF.

For some optical materials, it has been found that damage may occur at fluences more that 50 % below the conventionally measured damage threshold. These conventional thresholds are determined by measurement on small witness samples. Due to advances in fabrication technology, the number of damage causing defects have been reduced to the level that the defects may be missed when only a small area of a witness sample is tested. The area tested in a conventional test is typically only 0.02% of the area of a full size NIF optic. This has led the group to construct several systems for testing apertures as large as that of the NIF optics.

There are three systems available for large area, high fluence, testing. The first is PLATO (Probed Large Area Testing of Optics), which uses a commercial Nd:YAG laser to generate 2 joule, 10 ns pulses at 10 Hz. When the 1064 nm light is converted, more than 500 millijoules of 355 nm light is produced. A beam diameter of 1.5-2 mm is generated on the sample, and a large XY translation stage moves the optic through the stationary beam in a raster style pattern. A scatter measurement diagnostic allows on-the-fly evaluation of laser-induced damage during a scan. Optics with dimensions up to 1 meter and weighing as much as 400 pounds may be tested on this station. A second system uses the PLATO configuration, only for smaller samples up to 20 cm square. The third test system uses LLNL's Beamlet laser, a single beam prototype of the NIF, to damage test optics using a 10 cm by 10 cm beam at wavelengths of 1053 nm or 351 nm.

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